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Investigation of the Relationship Between the Climatic Role of Iwan and Rate of Energy Consumption in Traditional Houses of Tabriz

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Abstract

This research studies the reaction of traditional houses to solar energy according to the function of Iwan as well as the climate in Tabriz city. It aims to investigate the climatic role of Iwan in the rate of energy consumption of these houses. Statistical population of this study contains four traditional buildings registered in Cultural Heritage Organization of the East Azarbayjan province. Solar conveyor system, content analysis, and survey methods with tools including the images, tables and maps have been used for investigating the cases in order to achieve this objective. Obtained results indicates that Iwan was applied only as the symbolic element in the architecture of traditional structures in Tabriz city and its climatic function was rarely considered in designing these structures.

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Keywords: Climate, Iwan, Solar energy, Traditional houses, Tabriz.

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1. Introduction

The issue of energy and the ways of taking the advantage of natural and renewable are of the most important ones which attract attentions at most nowadays. Houses are of the cases which consume the energy in urban scale. Cosidering the elements and appropriate architectural design of houses can decrease the significant use of non-renewable sources of energy and increase the use of renewable ones instead. Iwan is of the cases and elements that if constructed in homoginiety with climatic principles and conditions of each region, can be widely used in the case of being designed and built in consistency. However, it is worth noting that the concept of Iwan is not solely referring to what is seen in the traditional houses, but the present study aims to investigate the Iwans in Tabrizian houses and their climatic conditions. Therefore, a brief definition and history of this architectural element is mentioned before investigating the climatic principles of Iwan.

2. Methodology of Research

The method used in this study are Descriptive and Analytic. To achieve theoretical research, including information about climatic conditions, used the library and description methods and for to adjust the data obtained from the charts of solar conveyor.

3. Definitions of Iwan

In Persian, iwan means 'portico, open gallery, porch or palace' and the word liwan in Arabic covers the Persian concept [1]. In a book entitled “The Feel of Unity”, the concept of Iwan or porch has been specified as follows: The concept of Iwan or porch has profound implications throughout the Islamic history. Iwan represents the certain features and space limitation and it is in fact the "procedure" or transitional space between the world of time and earth. Based on the metaphysical point of view, Iwan can be considered as the whole designation which sets a stream between the garden or yard of the soul and the room as a physical stage [2].

Iwan, as defined in the Ensyclopedis of Dehkhoda, is the platform and vault, high seat with ceiling. A house and room with open front and entrance. Iwan, also has been described as the projections with walls at both sides, or as the half-open columned spaces which are next to the rooms in different forms [3], but in general, it can be defined as the half-open space which is enclosed at three sides and open at one side. Iwan, in fact, is considered as a space ahead and emphasizes on the entrance. Iwans are usually built as a connecting space in order to exis or inter a space. Definitions given above have put the emphasis on the totality of Iwan. However, according to other definitions, Iwan can be described as the space which brings out a variety of experiences for life compared to closed and open spaces via providing the shade and direct perspective towards tree and greenery.

Iwan is the oldest model of the indoor spaces in Iranian houses the construction of which was considered as a necessity until the early twentieth century. Iwan is a closed and independent space with high vault which is considered for all activities of life. One of its sides is open overlooking the yard and the other two sides are half-closed and the fourth side is closed. The closed side has usually directed to the rooms of royal seat (Shahneshin); and the space of Shahneshin is integrated with Iwan by opening the doors and windows of this room and it makes the numerous activities possible. Two other sides are connected to other spaces through passing spaces and false arches [4].

4. Iwan History

Even though its origins are obscure, some researchers thought that the iwan, probably, developed in Mesopotamia [5]. However, Reuther (1967,430) advanced the notion that iwans did not emerge from the habits of the sedentary people of Babylonia or Assyria, but rather from the tradition of a people accustomed to moving in open air, viewing the blue sky and living in tents or reed huts as shelters against sun and wind. Colledge (1967,120) found it to be at home in Persia, for it is the standard feature of late Iranian architecture. On the other hand, iwan-like rooms of the late Hittite palaces (beginning of the first millennium B.C.) at Zinjirli and the barrel vaulted matted straw covered rush huts (sarifa) of the dwellers of the Babylonian marshes are considered to be the prototypes of the

later iwans [1]. It seems more reasonable to accept the iwan-like room at Zinj irli as a fortuitous formation and to take sarifa as an unspecified model which could be engendered in an early period under similar life conditions hic et ubique, whence more evolved forms later developed from these primitive origins.

Among the hypotheses about the genesis of Iwan, the viewpoint of those who have considered Iwan as the stone tent, is remarkable. According to the viewpoint of this group, the nomadic people who decided to live in the village, promoted the application of three-wall rooms in order to keep contact with nature. Besides the presence of ambiguity on the way the Iwan has appeared, the scientists who have made investigations in Iran have specified it as a outstanding phenomenon in the Iranian architecture [6]. Iwans were used by the Hakhamanesh's in Apadana and Pasargad palaces and then at next periods like Ashkani's and Sassani's; but the peak of its use dates back the period after Islam specially Safavie's and Qajar's eras. During the Qajar era, Iwan was built at one or more sides of the building and was considered as the main facade of building.

Fig. 1. Existence of Iwan in Tabriz during the past eras [5].

5. The Role of Iwan in building

As it was mentionned before Iwan had taken its palace in various urban elements like mosques, palaces, ete.; but its main use specifically during and after the appearance of Islam was in houses. Presence of Iwan in the house in addition to the residence value and providing the special environmental life situation, results in creation of a special atmosphere with a diversity in performance and space for independence and distinctiveness of public and private spaces and continuity of inside a towards outsideand vice-versa. The table below paid to the investigation of Iwan patterns and its of old houses.

5-1. The Symbolic purpose of the monumental Iwan

Oleg Grabar believes that in any Islamic period the iwan could have been used for various purposes defined by the needs and tastes of the people, and it is preferable to interpret it as one of the ways with which Islamic architects solved the problem of architectural space without attributing to it concrete symbolic meanings [7]. On the other hand, Creswell proposed that in Egyptian madrasas each iwan represented one of the four Islamic sects. But this latter view is not so convincing, for according to Kuran, if the buildings of the Anatolian Seljuks are taken into consideration, then even though the Seljuks were from the Hanefid branch of the Muslim faith, we find the courtyard with four iwans present not only in madrasas but in mosques and caravanserais as well.

It is stated above that the grottos of the Urartians were identified as the forerunners of the late iwans [8]. One of the most convincing hypotheses on the function of the Urartian cave niches is that gods were thought to haveappeared from inside of these niches [9]. Relying on this premise, it can be surmised that the iwan was a kind of symbolic gate giving way to the underworld where supernatural powers dwell [8]. These cave niches in Eastern Anatolia preceded the carved temples of the Mithras cult. God Mithra, as the life renewing and light generating (genitor luminis) creator, was believed to have appeared from inside a birth-giving rock near a river bank under the

shadow of the sacred fig tree. Accordingly, people venerated Mithra at a natural rock near a natural water source [10].

6. Iwan classification

The Iwans can be classified both in terms of shape and walled body. Regarding the shape, Iwans are classified into two groups of single and overall

6.1. Overall Iwan

These Iwans have been built in early more created in early and middle periods. Generally, they have rectangular shape which in some cases changed into trapezoid due to the changes in the corners by the lateral elements. Overall Iwans are generally located along with the main axis of structure and on the southern side of Tanabi with two floors of height. In some cases, overall Iwan is palced between two protruding Tonbi lateral room. In some cases also, overall Iwan is also elongated along the southern facade [11]. For the stability of Iwan columns have been taken into account and different entrances have been resulted depending on location and proximity of the these columns.

In some cases, the front section of Iwan has decoration which are mainly plasterworks. In some of these Iwans which are related to the medieval eras, a pediment is located in the center for making the center to focus on Iwan and this implies that it is imported.

6.2. Single Iwans

These iwans are mainly related to the recent period and have generally the rectangular shape. This is due to the extroverted approach of recent houses in which the Iwan. Has been built in a protruding state which attracts the attention and brings abute the manifestation in the facade. Single Iwans and accessible through the same space [11].

7. Accessibility of Iwans and its body enclosure

In terms of accessiblity, the overall Iwans are located in the ground floor and overlooking the courtyard. They are accessible through the yard. Single iwans are accessible through the same space since they are allocated to. These iwans are in disposal for the rooms or the corridors which in any of the cases they are accessible through the same room or corridor. Iwans, in terms of body enclosure are also classified into three main groups of a) one enclosed - three open sided, b) two enclosed - two open sided, and c) three enclosed - one open sided iwans [12].

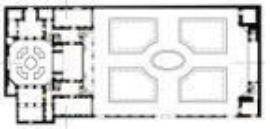
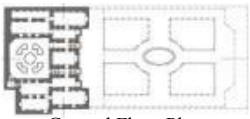
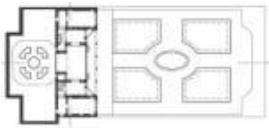
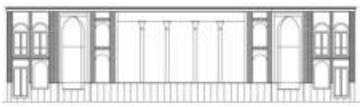
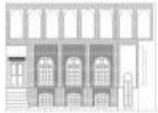
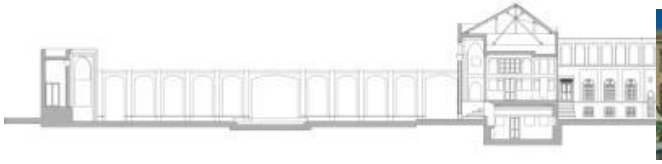
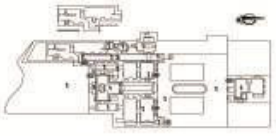
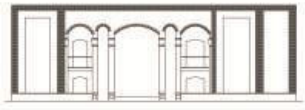
8. Investigating the climatic condition of Tabriz and the climatic role of Iwan in it

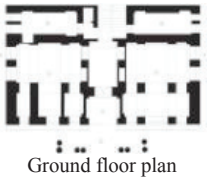
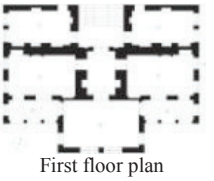
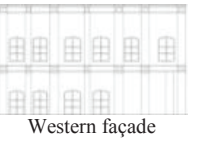
Tabriz city is located in the north-western part of Iran and in the mountainous region with a cold and dry climate which has cold winters and temperate summers. On the other hand, investigating the climatic role of iwan in Tabrizian houses, we can conclude that Iwan, in most of cases, is located along the main axis of structure. This space is more in the southern side of Tanabi and this made the Tanabi to have an optimal advantage of southern sunlight [13]. This element also protects the windows, sashes and bodies of the house from the atmospheric factors such as rain and snow.

In recent structures, Iwan is built along the main and subsidiary axes of structure. Therefore, the existence of iwan at the initial layer of the building keeps its aesthetics role as well as the climatic role in the initial layer of structure role through protecting the main body of structure from direct sunlight in summer and as a result providing the shade and thus keeping the inside cool [14]. And in winter the iwan acts as a cover which prevents the penetration of coldness into the building [15]. However, iwan in some building do notplay such a role and hence this question come into the mind that whether these iwans play only their decorative role or the climatic role has been taken into consideration as well? To answer this question case, four traditional houses of Tabriz were selected according to the

latitude and direction and their standards were separately investigated through the "Solar Conveyor System" [16] and the result can indicate and identify that whether the existence of iwan has had climatic or decorative role at each building.

Table1-Introduction of structures based on maps and images

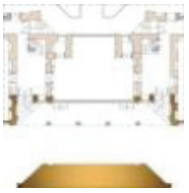
Behnam House			
Plan	 Basement Floor Plan	 Ground Floor Plan	 First Floor Plan
Facade	 Northern facade	 Southern facade	 Eastern and western facade
Cross section and image			
Mojtahedi House			
Plan	 Basement Floor Plan	 Ground Floor Plan	 First Floor Plan
Façade	 Northern facade of northern building	 Southern facade of southern building	 Northern facade of southern building
Cross section and image			
Alavi House			
Plan	 Basement Floor Plan	 Ground Floor Plan	

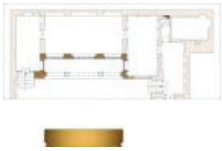
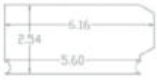
Facade	 Western façade	 Southern facade
Cross section and image		
Kalantari House		
Plan	 Ground floor plan	 First floor plan
Facade	 Southern façade	 Western façade
Cross section and image		

Source: Authors

9. Investigating the enclosed body and occupied area

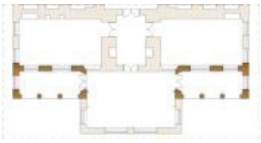
Table 2- Calculating the occupied ares of Iwan in floors

No:	House	Space shape	Coverage	Space dimensions
1	Behnam			$\frac{space\ area}{Floor\ area} = \frac{30.4}{528.5} \approx 6\%$
2	Mojtahedi	 		$\frac{space\ area}{Floor\ area} = \frac{34}{841} \approx 4\%$

3	Alavi			$\frac{space\ area}{Floor\ area} = \frac{24}{315} \approx 8\%$
4	Kalantari			$\frac{space\ area}{Floor\ area} = \frac{30}{316} \approx 10\%$

Source: Authors

Table 3 - Investigation of Iwan in terms of enclosed body

Type of enclosing in Iwan			
House	One enclosed side - three open sides	Two enclosed sides- two open sides	Three enclosed sides- One open side
Behnam		———	———
Mojtahedi		———	———
Alavi		———	———
Kalantari	———		———

Source: Authors

10. Climatic investigation of structures

In order to investigate the solar radiation in the region, the height and direction of sun will be annually calculated for several some of the hours in a day[17]. Also, since the rate of solar radiation affects the energy received by the vertical surfaces according to different directions and angles of sun during the year and it is among the effective factors in climatic design, thus the rate of energy received by the vertical surfaces in July and January is calculated for four different hours in southern wall through using the chart of sun position and adoption of solar energy conveyor [18]. The following table investigates these factors.

Table 4- Calculating the angle and direction of radiation at latitude 38°

Hours of day / Months of year	$\beta < 90^{\circ}$ (β = Angle of radiation)				$Z < 180^{\circ}$ (Z = direction of radiation)			
	9 am	12 pm	15 pm	18 pm	9 am	12 pm	15 pm	18 pm
July	50	77	52	13	97	180	97	70
January	16	30	16	0	138	180	137	0

Source: Authors

Table 5- Calculating the rate of energy radiated in July on vertical surfaces in terms of Btu/h/ft2

Hours of day / Houses	9 am	12 pm	15 pm	18 pm
Behnam	37.5	65	5	0
Mojtahedi	25	69	10	0
Alavi	20	72	15	0
Kalantari	20	72	15	0

Source: Authors

Table 6- Calculating the rate of energy radiated in January on vertical surfaces in terms of Btu/h/ft^2

Hours of day / Houses	9 am	12 pm	15 pm	18 pm
Behnam	142	205	120	0
Mojtahedi	135	205	122	0
Alavi	130	205	130	0
Kalantari	130	205	130	0

Source: Authors

Table 7 – Calculating the angle between the line perpendicular to the to the axis of window and southern axis

Axes / Houses	N_N	N_E	N_S	N_W
Behnam	174	84	354	264
Mojtahedi	175	85	355	265
Alavi	180	90	0	270
Kalantari	180	90	0	270

Source: Authors

Table 8 – Calculation of canopy depth in terms of cm

Months of year	July				January			
Canopy depth	D_s				D_s			
Hours of day / Houses	9 am	12 pm	15 pm	18 pm	9 am	12 pm	15 pm	18 pm
Behnam	9	84	280	750	850	600	850	0
Mojtahedi	125	117	115	900	117	833	116	0
Alavi	30	70	30	433	700	500	700	0
Kalantari	15	35	14	222	350	250	350	0

Source: Authors

11. Conclusion

According to the obtained sizes from calculation of the canopy depth and considering the maximum depth and its adaptation with actual sizes of Iwan in the investigated structures, the following results are obtained. These results indicate that the Iwan has often the decorative function in Tabriz climate and is rarely used as a climatic element.

Table 9 – Adapting the existing and climatic depth of canopy and Iwan

Months	July			January		
Houses	Existing depth	Climatic depth	Results	Existing depth	Climatic depth	Results
Behnam	251	750	Inappropriate	251	850	Inappropriate
Mojtahedi	630	900	Inappropriate	630	833	Inappropriate
Alavı	230	433	Semi-appropriate	230	700	Semi-appropriate
Kalantari	254	222	Favorable	254	350	favorable

Source: Authors

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